wire from the sensor. Further, stray field interference may, in some cases, result in different measurements being obtained by the two sensors.

[0053] At block **908**, the processor **208** calculates a second differential signal based on the two magnetic sensor signals from the second pair of magnetic sensors. As described with respect to the block **904**, the differential signal may be created by taking a difference of the signals from the two magnetic sensors. Further, as with the block **904**, a scaler value may, in some embodiments, be applied to the differential signal, or to each of the magnetic sensor signals. Moreover, as with the block **904**, the block **908** may alternatively or additionally calculate an aggregate value for the output of the pair of magnetic sensors. The values generated by the second pair of magnetic sensors may be used to facilitate measurement of the current in the wire in a second direction differing from the direction of the line connecting the first pair of sensors. Each additional pair of sensors may help improve the measurement of the current in the wire being measured while reducing the impact of stray field interference from signals near the target measurement zone.

[0054] At block **910**, the processor **208** derives a measure of the current flowing through a wire based on the first differential signal and the second differential signal. For an individual sensor, the sensor output is proportional to the measured current and inversely proportional to the distance between the target current and the sensor. $V=\alpha\ I/d$. This formula can also be written as $I=\beta\ V^*d$. The constant β can compensate for a single distance. As the distance changes (such as when the wire moves around in the region of accuracy) an error in the current measurement estimate may be introduced. By utilizing two (or more) sensors, each sensor can be positioned so that as the distance between the current and the first sensor increases, the distance between the second sensor decreases. This method helps mitigate position/distance uncertainty in one dimension, but may not completely eliminate the error. Generally, the sensor distance compensation method works best if the sensors are placed far apart, centered around the region of interest; however, the farther apart the sensors are, the more prone the measurement is to stray fields. Increasing the number of sensor pairs allows distance/position compensation in additional dimensions. With each added sensor pair, the tradeoff between stray field rejection and accuracy in the target region should be considered.

[0055] Advantageously, some of the embodiments disclosed herein have been demonstrated to provide improved accuracy and reduced interference compared to existing systems. For example, with reference to the sensor configuration of FIG. **5**, the outputs of eights sensors may be combined into six sensor pairs. These outputs may be scaled with a linear scaling factor and combined. The 6 sensors pairs are V**3**−V**4**, −V**1**−V**2**, V**3**+V**4**, V**7**−V**5**, V**7**−V**8**, −V**5**−V**6**. Each of these pairs may be provided a scaling factor of −0.007, 0.028, 0.028, −0.004, −0.0158, and −0.0158 respectively. When the resulting scaled formula is evaluated over a 2 dimensional space, the resulting stray field rejection (FIG. **7**A) and accuracy (FIG. **7**B) plots show the sensor output may be combined in an manner to provide an accurate current reading in the target region while providing minimal reaction to current placed in positions corresponding to stray currents. For example, a stray current placed 40 mm from the center is reduced by over −40 dB. This is a significant improvement over some existing systems, which may be represented by the rejection pattern shown in FIG. **1**B, and which shows worse than −26 dB rejection of stray fields, even as the interference is placed over 100 mm from center.

[0056] As previously described, the current measuring apparatus **202** may include more than two pairs of sensors. For example, the current measuring apparatus **202** may include eight sensors. In such embodiments, operations associated with the blocks **902** and **904** (or **906** and **908**) may be repeated for each pair of sensors. The resulting differential signals may be combined at the block **910** to obtain a measurement of the current flowing through the wire being measured.

TERMINOLOGY AND CONCLUSION

[0057] Principles and advantages discussed herein can be used in any device to measure the current flowing through a wire. Further, embodiments disclosed herein can be used to increase a zone or area in which a wire can be located during measurement of the current flowing through the wire thereby making it possible to measure the current in wires that are awkwardly positioned or are blocked by other components. Further, embodiments disclosed herein improve the accuracy of the current measurement and/or reduce the impact of stray field interference on the current measurement in the wire.

[0058] It is to be understood that not necessarily all objects or advantages may be achieved in accordance with any particular embodiment described herein. Thus, for example, those skilled in the art will recognize that certain embodiments may be configured to operate in a manner that achieves or optimizes one advantage or group of advantages as taught herein without necessarily achieving other objects or advantages as may be taught or suggested herein.

[0059] Some or all of any the processes described herein may be embodied in, and fully automated via, software code modules executed by a computing system that includes one or more computers or processors. The code modules may be stored in any type of non-transitory computer-readable medium or other computer storage device. Some or all the methods may be embodied in specialized computer hardware.

[0060] Many other variations than those described herein will be apparent from this disclosure. For example, depending on the embodiment, certain acts, events, or functions of any of the algorithms described herein can be performed in a different sequence, can be added, merged, or left out altogether (e.g., not all described acts or events are necessary for the practice of the algorithms). Moreover, in certain embodiments, acts or events can be performed concurrently, e.g., through multi-threaded processing, interrupt processing, or multiple processors or processor cores or on other parallel architectures, rather than sequentially. In addition, different tasks or processes can be performed by different machines and/or computing systems that can function together.

[0061] The various illustrative logical blocks and modules described in connection with the embodiments disclosed herein can be implemented or performed by a machine, such as a processing unit or processor, a digital signal processor (DSP), an application specific integrated circuit (ASIC), a field programmable gate array (FPGA) or other programmable logic device, discrete gate or transistor logic, discrete hardware components, or any combination thereof designed